

# We're going through changes: How change of state verbs and arguments combine in scale composition

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## Abstract

The role of scalarity has attracted increasing attention in recent analyses of verb-related phenomena such as aspectuality (telicity and durativity) and argument realization. A central issue in this regard is which types of verbs express a scalar change and which do not. There is some agreement that incremental theme verbs do not come with a scale but instead depend on an incremental theme argument which introduces the scale. By contrast, it is assumed that change of state verbs already lexicalize a scale as part of their meaning and may therefore be considered as scalar verbs. In this paper, we tackle the question whether all change of state verbs are scalar in the sense that they fully lexicalize a scale. We argue that a change of state verb can be scalar, even if not all of the scale parameters are lexically specified, and propose a typology of scalar underspecification. We discuss two types of strategies that are applied for the resolution of scalar underspecification: (i) introduction of a missing parameter by the context and (ii) composition with a scale-denoting argument. We focus on the compositional aspects of scale structure and illustrate the interaction between verbs and arguments in building scalar changes.

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## 1. Introduction

A number of recent analyses ([Rappaport Hovav, 2008](#); [Beavers, 2006, 2008](#); [Kennedy and Levin, 2008](#); [Rappaport Hovav and Levin, 2010](#) among others) assume that change of state verbs incorporate a scale as part of their lexical meaning. The temporal sequence of states referred to by a change of state verb can then be captured as a set of degrees which are ordered along the scale. For instance, the change of state denoted by the verb *warm* is described as a change along the temperature scale such that the temperature degree reached at the end of the event is higher than the temperature degree at the beginning. Although the scalar approach allows for a precise analysis of the internal structure of change of state verbs, it needs to be clarified what it means for verbs of this type to lexicalize a scale.

In the paper, we tackle this question based on a discussion of different types of German change of state verbs. Starting out from the parametric definition of scales proposed by [Kennedy \(1999\)](#) and [Kennedy and McNally \(2005\)](#), we argue that change of state verbs lexicalize a scale even if one or more of the parameters of the scale are underspecified in the lexical meaning of the verb. In the first part of the paper, we present evidence for this view and propose a typology of change of state verbs in terms of scalar underspecification. In the second part of the paper we focus on the resolution of scalar underspecification and discuss two different strategies for the specification of scale parameters missing in the meaning of the verb. The first strategy consists of adding scale parameters by means of context. The second strategy is the

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introduction of scalar information via an argument of the verb. We show how a full-fledged scale is yielded by composing the scalar meaning contributed by the verb and the argument. In this regard, we will also discuss different patterns of argument realization exhibited by change of state verbs.

Since our research grew out of an investigation of German verbs encoding change along a single dimension, our analysis is based on German data. As will become clear from the English translations, English behaves similarly in many respects although there are also a number of marked differences we will not address in this paper. For instance, German – as opposed to English – applies reflexives to derive intransitive change of state verbs from transitive (causative) verbs and also makes frequent use of verbal prefixes, which contribute to the meaning of the base verb in various ways.

## 2. Scalar change and the lexicalization of scales

A basic distinction with respect to verbs is the one between stative and dynamic verbs. Dowty (1979) assumes that all dynamic verbs express changes which can only be evaluated at a time interval.<sup>1</sup> By contrast, stative verbs do not express changes and can be evaluated at a single point of time. Rappaport Hovav (2008) and Rappaport Hovav and Levin (2010) build on this assumption and propose a further subdivision of dynamic verbs by distinguishing between scalar and nonscalar changes. Scalar changes can be measured along a scale which is defined as a linearly ordered set of degrees along a dimension such as TEMPERATURE and SIZE.<sup>2</sup> On the other hand, nonscalar changes can be either undirected changes in a certain dimension or complex, i.e. multidimensional, changes. According to Rappaport Hovav and Levin (2010) the distinction between scalar and nonscalar changes corresponds to the distinction between result and manner verbs.

Verbs like *warm* and *grow* are scalar since they denote a change along a single, specified dimension (TEMPERATURE and SIZE, respectively). They also qualify as result verbs since they express the attaining of a specific result, which is an increase in temperature or size.<sup>3</sup> Rappaport Hovav and Levin (2010) distinguish two types of nonscalar change verbs: First, verbs like *dance* express some kind of motion in space which, however, is not directed towards a goal so that verbs of this type denote an undirected change. Second, verbs like *hit* express a complex change rather than a specific result. Both *dance* and *hit* specify the manner of some action, but not the achievement of a specified result. Here, we follow the analysis of Rappaport Hovav and Levin, keeping in mind that this view is not uncontroversial (cf. Beavers and Koontz-Garboden, 2012 for arguments against a strict manner/result complementarity and Beavers (2011) for arguments in favor of a latent scalar structure of verbs of impact like *hit*).

Based on Tenny (1994), Hay et al. (1999), Beavers (2008) and others, Rappaport Hovav and Levin (henceforth RHL) distinguish three different kinds of scales which occur with verbs of different classes: (i) property scales are associated with change of state verbs such as *warm* and *grow*; (ii) path scales appear with verbs of directed motion such as *rise* and *enter*, which refer to an entity moving along a path; (iii) extent scales co-occur with incremental theme verbs such as *read* and *eat*. RHL assume that the three scale types also differ with respect to the degree to which they are lexicalized in verbs. Property scales are fully lexicalized in change of state verbs. Path scales are characteristically only partially lexicalized in inherently directed motion verbs. According to RHL only a few motion verbs such as *rise* and *descend* lexicalize all components of a path scale. Finally, RHL argue that incremental theme verbs do not specify any components of a scale.

We do not have anything to contribute to the lexicalization of path and extent scales. In particular, it remains a matter of debate whether incremental theme verbs are lexically scalar or not. For the sake of argument, we accept Rappaport Hovav's assumption and concentrate on the lexicalization of property scales in the following. Again we agree with RHL that property scales are fully lexicalized by the most typical instances of change of state verbs. However, based on evidence from German change of state verbs, we will show that this assumption can be refined in various directions.

First, RHL do not consider stative verbs in their discussion of scalarity. Yet, there are also stative verbs which encode property scales. As argued by Gamerschlag (submitted for publication) for German,<sup>4</sup> stative verbs can also be subclassified with respect to scalarity: Scalar stative verbs like *kosten* 'cost' and *wiegen* 'weigh' encode a single dimension such as PRICE and WEIGHT whose values are ordered on a dimension-specific property scale. As with dynamic scalar verbs, stative scalar verbs allow for the specification of a value by means of a measure phrase as in (1a). Moreover, stative scalar verbs lend themselves easily to comparison constructions as illustrated in (1b). As shown in (1c), stative

<sup>1</sup> In this context "change" is used as a general notion for all dynamic predicates. This broad notion has to be distinguished from the notion of "change of state", which denotes changes in a property of an entity.

<sup>2</sup> We use small capitals when referring to dimensions.

<sup>3</sup> Note that *warm* and *grow* are degree achievements (cf. Dowty, 1979; Hay et al., 1999; Kennedy and Levin, 2008) which do not entail the achievement of a definite, but only a comparative result. If, for example, someone grows s/he does not necessarily get tall, only taller.

<sup>4</sup> Rahul Gawron (2009) and Koontz-Garboden (2010) also discuss scalar properties of statives such as the extent uses of change of state verbs like *widen* and deverbal result states like *darkened*. However, there are also simple instances of underived stative verbs which are lexically scalar such as German *kosten* 'cost', *wiegen* 'weigh', and *dauern* 'last'.

scalar verbs are closely related to constructions based on dimensional adjectives which are associated with the same scale.

- (1) a. *Der Koffer wiegt 10 Kilogramm.*  
the suitcase weighs 10 kilogram  
'The suitcase weighs 10 kilograms.'
- b. *Der Koffer wiegt 1 Kilogramm mehr als der Rucksack.*  
the suitcase weighs 1 kilogram more than the backpack  
'The suitcase weighs 1 kilogram more than the backpack.'
- c. *Der Koffer ist 1 Kilogramm schwerer als der Rucksack.*  
the suitcase is 1 kilogram more than the backpack  
'The suitcase is 1 kilogram heavier than the backpack.'

As with dynamic verbs, there is also a scalar/nonscalar opposition to be found with stative verbs such that scalar stative verbs like *wiegen* 'weigh' and *kosten* 'cost' contrast with nonscalar stative verbs like *wissen* 'know' and *existieren* 'exist', which do not encode a scale. Taking into account stative verbs, one arrives at the simple verb classification in Fig. 1 below which results from distinguishing verbs with respect to change, i.e. dynamicity, and scalarity.

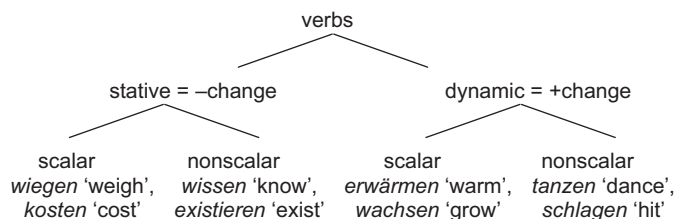


Fig. 1. Classification of verbs in terms of change and scalarity.

Second, although typical instances of change of state verbs lexicalize a complete scale, there are also change of state verbs which are underspecified with respect to scalarity. In the remainder of the paper, we are concerned with change of state verbs (henceforth CoS verbs) with incomplete scales.

Any analysis of scalar verbs requires a proper definition of scales. According to Kennedy and McNally (2005), scales consist of three parameters which are (i) a measurement dimension ( $\Delta$ ), (ii) a set of degrees ( $D$ ) and (iii) an ordering relation ( $R$ ). The measurement dimension indicates the kind of measurement and how the degrees are interpreted. Examples of such dimensions are TEMPERATURE, HEIGHT and WEIGHT. The respective sets of degrees are interpreted as temperature values, height values and weight values. Finally, the ordering relation determines the linear order of degrees. All of the three parameters are explanatorily relevant. Parameter  $R$ , the ordering relation, is used in Kennedy's and Kennedy and McNally's account to distinguish between antonymous adjectives like *warm* and *cold*. These adjectives operate in the same dimension, but induce an inverse linear order of the temperature values. Parameter  $\Delta$ , the measurement dimension, is applied for example by Kennedy and McNally (2005) in explaining incommensurability phenomena as illustrated in (2). The sentence is odd because it expresses a comparison in the two different measurement dimensions HEIGHT and AGE.

- (2) #*The girl is taller than the boy is old.*

The last parameter  $D$ , which is the set of degrees, specifies whether a minimal and/or maximal scale value exists. A maximal scale value is the highest degree, so that no higher degree exists. The reverse holds for minimal scale values. The presence versus absence of minimal and maximal scale values determines one of the formal characteristics of scales, namely whether they are (partially) closed or open. Different authors relate scale structure to telicity, assuming that telic predications are related to closed scales and atelic ones to open scales (e.g. Hay et al., 1999; Caudal and Nicolas, 2005; Kennedy and Levin, 2008). We will not discuss this aspect further since telicity is not the topic of our analysis.

According to RHL (2010) CoS verbs are scalar and lexicalize a scale that measures the progression of the change expressed by the verb. The dimension of the scale represents an attribute of the referent of the theme argument. The identification of the dimension of the scale with an attribute of the theme argument allows for an explanation of selectional restrictions: A particular scalar verb can only be applied to an argument if the dimension of the scale is also an attribute of the argument. Moreover, RHL explicitly assume that CoS verbs lexicalize a complete scale, i.e. all components or

parameters of the scale. This assumption can be formulated as a hypothesis on the lexicalization of scales by CoS verbs. The strong version of this hypothesis, given in (3), is that all three scale parameters are part of the verb's lexical meaning.

- (3) Lexicalization of scales (strong version): If a change of state verb lexicalizes a scale, all scale parameters are specified in the lexical meaning of the verb.

The strong version of the hypothesis is adequate for a large range of CoS verbs such as *verbreitern* 'widen', *verdunkeln* 'darken' or *wachsen* 'grow'. For instance, all three scale parameters can be specified for *verbreitern* 'widen' as in (4). Since *verbreitern* 'widen' is deadjectival like *widen*, the scale is inherited from the base adjective (cf. Kennedy and McNally, 2005; Kennedy and Levin, 2008).

- (4) *verbreitern* 'widen' ( $\Delta$ : WIDTH, D: size values, R: <)

However, the strong version of the hypothesis turns out more problematic for other CoS verbs like *sich verfärben* 'change color'<sup>5</sup> and *steigen* 'rise'. As illustrated in (5) below, *verfärben* encodes a change along the dimension COLOR and allows for the specification of color values. Color space is structured (cf. Gärdenfors, 2000) but colors are not linearly ordered and consequently do not form a scale. The change expressed by *verfärben* can be analyzed as an arbitrary sequence of colors with the initial color of the referent of the theme argument as the starting value of the change and the color value at the end of the change as the final value. This change is not directed, e.g. it could be one from green to blue, but it could equally be in the opposite direction from blue to green.

- (5) *Nach dem Waschen hat sich das Hemd blau verfärbt.*  
 after the washing has REFL the shirt blue changed.color  
 'After washing the shirt has changed color to blue.'

A similar case in the domain of motion verbs is discussed by RHL, who assume that the verbs *cross* and *traverse* do not express a scalar change: "Although they [*cross* and *traverse*] lexically specify motion along a path defined by a particular axis of the ground, the direction of motion along this path is not lexically specified and, hence, they do not impose an ordering on the points on the path. [...] the verb *cross* is equally applicable whether a traversal of the England Channel is from England to France or from France to England" (Rappaport Hovav and Levin, 2010:30).

In spite of the similarities between *cross* and *verfärben*, we claim that *verfärben* is a verb which expresses a scalar change. As a consequence, we assume that a verb can be scalar even if its meaning does not fix a particular linear order of the values of the encoded dimension. In the next section we will provide evidence for this claim.

While *verfärben* lexically specifies at least two of the scale parameters, some inherently directed motion verbs which basically refer to motion along a path allow for a metaphoric use in which none of the scale parameters is part of the verb meaning. These two distinct uses can be characterized as *extensional* versus *intensional* use (Montague, 1973; Löbner, 1979, 1981). In the extensional use, a verb like *steigen* refers to the change of the theme along a single dimension, as in *Der Ballon steigt* 'The balloon is rising', which exclusively refers to a change with respect to the HEIGHT of the subject referent as it moves along a vertical path. By contrast, the intensional use is characterized by the nominal explication of the scale as in *Die Temperatur steigt* 'The temperature is rising', which involves a total change of the subject referent. As a result, replacing the subject with an expression which refers to the referent of the subject at a specific point of time yields an awkward sentence such as #26 Grad Celsius *steigen* lit. '26 degrees Celsius are rising'. This is opposed to a partial change characteristic of the extensional use, in which case the reference of the subject does not change. Consequently, the subject can be replaced by an expression with the same reference as in *Das Gefährt der Brüder Montgolfier steigt* 'The vehicle of the Montgolfier brothers is rising.' In the following we will focus on the intensional reading of *steigen*. For the sake of simplicity we implicitly refer to this use of the verb unless mentioned otherwise.

The intensional use of *steigen* 'rise' is illustrated in (6). The examples show that the scale to which the change is related depends on the choice of the subject. In (6a), the subject *Temperatur* 'temperature' introduces the temperature scale and accordingly the values are temperature values. By contrast, *Preis* 'price' in (6b) and *Druck* 'pressure' in (6c) refer to the price and pressure scale, respectively. Consequently, the sentences in (6b) and (c) denote a change with respect to price and pressure.

<sup>5</sup> In German intransitive CoS verbs are often derived from transitive causative verbs by means of reflexivization with *sich* which marks de/ anticausativization. Since we want to focus on the change of state component and do not want to discuss causative aspects of CoS verbs, we use the reflexivized variants in the examples. We also sometimes use the reflexive variant as a citation form if we want to refer unambiguously to the intransitive CoS verb.

- (6) a. *Die Temperatur der Flüssigkeit steigt.*  
 the temperature of.the liquid rises  
 'The temperature of the liquid is rising.'
- b. *Der Preis des Apartments steigt.*  
 the price of.the apartment rises  
 'The price of the apartment is rising.'
- c. *Der Druck in der Kabine steigt.*  
 the pressure in the cabin rises  
 'The pressure in the cabin is rising.'

Since the subject arguments contribute complete scales, *steigen* does not specify any of the scale parameters in its meaning. At first sight, it may seem counterintuitive that *steigen* does not lexicalize an ordering relation since it refers to some kind of increase. However, we will show later that the specification of the 'direction of change', i.e. whether the change results in an increase or decrease of values, has to be differentiated from the ordering of scale values. As the meaning of *steigen* is reduced to the direction of change, it is the particular direction specified which differentiates *steigen* from the intensional use of the antonymous verb *fallen* 'fall'. Although the direction of change can be regarded as a fourth parameter relevant in the composition of scalar change (see Section 4), we do not regard it as an additional scale parameter in the stricter sense because a scale is already sufficiently defined by the three parameters proposed by Kennedy (1999) and Kennedy and McNally (2005).

Note that the change denoted by the examples in (6) is a change along a property scale rather than a change along a path scale as one might suspect since *steigen* basically refers to upward motion along a path. As shown by equivalent constructions with CoS verbs which incorporate the entire scale, the examples denote a change along a property scale. For example, (6a) can be paraphrased by the verb *erwärmen* 'warm' as in (7). Since according to RHL (2010) property scales are the only type of scale incorporated completely in CoS verbs, the scale encoded in the verb in (7) is a property scale. As a result, the scalar change referred to by (6a) is also a change along a property scale.

- (7) *Die Flüssigkeit erwärmt sich.*  
 the liquid warms REFL  
 'The liquid is warming up.'

Table 1 gives an overview of the scale components that are specified in the lexical meaning of the verbs discussed so far.

Table 1  
 Scale parameters lexicalized by different types of CoS verbs.

Verb	Dimension ( $\Delta$ )	Values (D)	Ordering relation (R)
<i>verbreitern</i> 'widen'	WIDTH	Size values	Increasing values
<i>verfärben</i> 'change color'	COLOR	Color values	–
<i>steigen</i> 'rise'	–	–	–

The verbs *verfärben* and *steigen* raise problems for the strong version of the lexicalization hypothesis since these verbs leave one or more of the scale parameters unspecified. Two different solutions to this problem seem reasonable. As one solution, one could assume that the problematic verbs do not express scalar changes but rather are instances of nonscalar CoS verbs. This would mean that the verbs "cannot be characterized in terms of an ordered set of values of a single attribute" (Rappaport Hovav and Levin, 2010:32) but instead express undirected or complex changes. In this case, not all CoS verbs would lexicalize a scale and CoS verbs would not constitute a semantically homogeneous class of verbs.

An alternative consists in weakening the hypothesis on the lexicalization of scales by CoS verbs. The weak version of the hypothesis given in (8) allows for an underspecification of scale parameters in the lexical meaning of a CoS verb, which renders all the verbs discussed in this section as scalar verbs.

- (8) Lexicalization of scales (weak version): A change of state verb lexicalizes a scale, even if one or more of the scale parameters remain unspecified in the meaning of the verb.

In the next section, we argue for the weak version of the lexicalization hypothesis and against the view that verbs like *verfärben* and *steigen* express nonscalar changes. We will discuss the criteria for scalarity that are proposed in the literature. The application of these criteria will show that *steigen* and *verfärben* pattern with indisputably scalar verbs like *verbreitern* 'widen'. Based on this evidence we will conclude that the weak version of the lexicalization of scales hypothesis is the empirically adequate one.

### 3. Evidence for scalarity

The distinction between scalar and nonscalar verbs requires criteria to decide whether a verb belongs to one or the other class. Rappaport Hovav (2008) mentions three criteria for the distinction between scalar and nonscalar verbs. The characteristics which are typical for scalar verbs are listed in (9).

- (9) a. Scalar verbs are restricted to result XPs that are compatible with the lexicalized scale.
- b. Scalar verbs can be telic without a measure phrase or explicit event delimitation.
- c. Scalar verbs do not allow for the deletion of the theme argument.

Result XPs are analyzed as scale-denoting predicates which denote the end state into which the theme argument changes (e.g. Rappaport Hovav, 2008). If a verb such as *gefrieren* ‘freeze’ is already scalar, the result XP must be compatible with the scale lexicalized by the verb as in (10a). This means that the result XP has to specify a value on that scale. Nonscalar verbs do not exhibit such a restriction for result XPs, since it is the resultative construction that introduces the scale of change. They are therefore compatible with XPs that introduce different kinds of scales.<sup>6</sup> As the examples in (10b) and (c) indicate, the incremental theme verb *essen* ‘eat’ and the activity predicate *schreien* ‘shout’ can be combined with result XPs which specify values belonging to various scales. This shows that the result XPs are not restricted by a lexicalized scale, while *gefrieren* ‘freeze’ only allows result XPs that are compatible with the change from liquid to solid already expressed by the verb. Note that nonscalar verbs like *essen* ‘eat’ and *schreien* ‘cry’ require the presence of the fake reflexive *sich*. This use of the reflexive differs from the use of the reflexive as a marker of de/anticausativization (see footnote 5).

- (10) a. *Der Fluss gefror zu Eis /#breit /#tief.*  
the river froze to ice /wide /deep  
‘The river froze solid/#wide/#deep.’
- b. *Peter aß sich #groß /krank /fett /zu Tode /glücklich.*  
Peter ate REFL tall /sick /fat /to death /happy  
‘Peter ate himself #tall/sick/fat/to death/happy.’
- c. *Das Kind schrie sich heiser /in den Schlaf.*  
the child cried REFL hoarse /in the sleep  
‘The child cried itself hoarse/to sleep.’

The second characteristic of verbs expressing scalar changes is the availability of a telic interpretation without a measure phrase or explicit event delimitation. That telicity is related to scalarity is an assumption held by different authors such as Tenny (1994), Jackendoff (1996), Ramchand (1997), Filip (1999), Hay et al. (1999) and Kennedy and Levin (2008). (11a) shows that *gefrieren* has a telic interpretation without explicit event delimitation, while *essen* in (11b) and *schreien* in (11c) do not have such an interpretation. The last two examples only allow for an ingressive interpretation that after an hour the respective eventuality started.

- (11) a. *Das Wasser gefror in einer Stunde.*  
the water froze in one hour  
‘The water froze in an hour.’
- b. *#Peter aß in einer Stunde.*  
Peter ate in one hour
- c. *#Das Kind schrie in einer Stunde.*  
the child cried in one hour

While it seems to be the case that telic predications are scalar, it is not the case that all scalar verbs are necessarily telic. Here, we follow the analysis of Kennedy and Levin (2008:177) which states that some deadjectival degree achievements as *widen* and *deepen* have only atelic interpretations by the absence of additional morphological or contextual information. The same holds for the German CoS verb *wachsen* ‘grow’ in (12).

- (12) *#Das Kind ist in einem Jahr gewachsen.*  
the child is in one year grown

<sup>6</sup> In this way, the test only holds for Talmy’s (2000) satellite-framed languages such as German or English, but not for verb-framed languages like French, Spanish or Italian. In these languages only scalar verbs license resultative constructions and they do not allow for strong resultatives as in (10b, c) (cf. Gehrke, 2008 and the literature cited therein).



Other clear instances of atelic scalar verbs are stative scalar verbs like *kosten* ‘cost’ and *wiegen* ‘weigh’ mentioned in the last section. Telicity is not a necessary criterion for scalarity and, as mentioned by RHL (2010:27), it fails to appropriately distinguish manner and result verbs. Since telicity is not a necessary condition for scalarity, we will not make use of this criterion in the remainder of the paper.

The third criterion is based on the assumption that the entity measured on a scale needs to be overtly realized in a sentence. Since it is the theme argument that is measured, it cannot be deleted with verbs expressing scalar changes. The omissibility of the theme argument indicates that the verb does not lexicalize a scale. This is illustrated by the contrast between (13) and (14): The incremental theme verb *essen* in (13) is not lexically scalar. Consequently, the theme argument *Brot* ‘bread’ can be omitted as in (13b). By contrast, *verbreitern* ‘widen’ in (14) encodes a scale and does not allow for the omission of the theme argument *Straße* ‘street’ as in (14b). As an additional contrast, *verbreitern* allows for the intransitive variant in (14c) in which the theme is realized as the subject whereas this option is not available for *essen* in (13c).

- (13) a. *Peter<sub>Agent</sub> aß das Brot<sub>Theme</sub>.*  
       Peter       ate the bread  
       ‘Peter<sub>Agent</sub> ate the bread<sub>Theme</sub>.’  
       b. *Peter<sub>Agent</sub> aß.*  
       Peter       ate  
       ‘Peter<sub>Agent</sub> ate.’  
       c. \**Das Brot<sub>Theme</sub> aß (sich).*  
       the bread   ate REFL
- (14) a. *Die Arbeiter<sub>Causer</sub> verbreiterten die Straße<sub>Theme</sub>.*  
       the workers       widened   the street  
       ‘The workers<sub>Causer</sub> widened the street<sub>Theme</sub>.’  
       b. \**Die Arbeiter<sub>Causer</sub> verbreiterten.*  
       The workers       widened  
       c. *Die Straße<sub>Theme</sub> verbreiterte sich.*  
       The street<sub>Theme</sub>   widened   REFL  
       ‘The street widened.’

A criterion for scalarity not mentioned by Rappaport Hovav is the use of scalar adverbs like German *graduell* ‘gradually’ and *sehr* ‘very, very much, a lot’. Piñon (2000) discusses the use of *gradually* in English and assumes that it can only combine with verbs that express multi-value scalar changes as illustrated for German in (15).<sup>7</sup>

- (15) a. *Das Apartment hat sich graduell verteuert.*  
       the apartment has REFL gradually become.more.expensive  
       ‘The apartment has gradually become more expensive.’  
       b. \**Das Kind hat graduell gegessen.*  
       the child has gradually eaten  
       c. \**Das Kind hat graduell geschrien.*  
       the child has gradually cried

*Gradually* can also be combined with verbs that do not express a scalar change. However, in this case, a coercion process from a state to a CoS verb occurs (*He gradually loved her*), or the gradual affection of a plural argument is expressed (*He gradually rescued the children*). For a deeper discussion of these cases see Piñon (2000).

At first sight, the sentence in (16) seems to be problematic for the *gradually*-criterion. Here, *gradually* modifies an incremental theme verb. In their transitive use incremental theme verbs are also scalar (cf. Beavers, 2012; Kennedy, 2012) and denote a change on a quantity scale, which is introduced by the theme argument. It is therefore not surprising that *gradually* can combine with transitive but not with intransitive uses of incremental theme verbs.

- (16) *The child gradually ate an apple.*

Degree adverbs like German *sehr* ‘very (much), a lot’ and English *a lot*, *very much* constitute a different type of scalar adverbs. These adverbs are not restricted to scalar change verbs, but can modify a huge range of verbs such as psych

<sup>7</sup> Cf. Gawron (2009:7) for the combination of *gradually* with stative extent verbs.

verbs (*He loves her very much*) or verbs of emission (*The dog smelled a lot*). In German, *sehr* can combine with CoS verbs as in (17a), but not with incremental theme verbs, irrespective of whether they are used intransitively or transitively as illustrated in (17b) and (c). If applied to CoS verbs, *sehr* specifies the degree of change, i.e. the resulting difference between the initial and the final state, as contextually large (cf. Fleischhauer, 2013). When *sehr* applies to verbs that do not express scalar changes, it specifies a value on, for example, an intensity scale as in (18).<sup>8</sup>

- (17) a. *Der Riss hat sich sehr verbreitert.*  
the crack has REFL very widened.  
'The crack widened a lot.'
- b. \**Er hat sehr gegessen.*  
he has very eaten
- c. \**Er hat (das) Brot sehr gegessen.*  
he has (the) bread very eaten

- (18) *Sie hat ihn sehr geliebt.*  
she has him very loved  
'She loved him very much.'

As mentioned by a reviewer, the tests introduced above are established on observable empirical asymmetries which require a deeper discussion providing a systematic explanation of these asymmetries as well as accounting for some interconnectedness between the tests. For instance, the introduction of a nonsubcategorized object by means of a fake reflexive in resultative constructions like *sich zu Tode essen* 'eat oneself to death' is closely related to the omissibility of the original theme argument. Addressing these aspects would go far beyond the limits of this paper but we think that such a discussion is not a necessary prerequisite for our argumentation. Moreover, one has to be careful in the choice of the verbal complements since they can affect the results of some of the tests. For example, as mentioned above, a plural theme DP allows for the modification by *gradually* even for nonscalar verbs. Likewise, the referential properties of the nominal arguments also have an effect on telicity. In order to avoid these factors we restricted the nominal arguments to singular quantized nouns.

Beavers (2008) and Rappaport Hovav and Levin (2010) distinguish between multi-point and two-point scales. Two-point scales only have two values and are related to achievements in Vendler's (1957) sense, while multi-point scales have more than two values and are related to accomplishments. *Gradually*, as well as degree adverbs, can only combine with verbs expressing changes on multi-point scales. In the remainder of this paper, we only discuss true accomplishments and leave achievements, such as *die* or *break*, aside.

It can be shown now that *verfärben* 'change color' and *steigen* 'rise', which we consider as problematic for the strong version of the lexicalization of scales assumption, pattern like scalar verbs with regard to the aforementioned scalarity criteria. As shown in (19), *verfärben* is highly restricted with respect to admissible result XPs, allowing only for color adjectives as result predicates.

- (19) *Das Laub verfärbt sich rot /#nass /#alt /#welk.*  
the leaves change.color REFL red /wet /old /limp  
'The leaves change color to red/#wet/#old/#limp.'

In the case of *steigen*, the admissible result XPs have to be compatible with the dimension specified by the subject. If the subject refers to the dimension PRICE, the admissible result XP has to denote price values. As illustrated in (20) other XPs are not possible.

- (20) *Der Preis des Buchs steigt auf 10 Euro /#neu /#rot.*  
the price of.the book rises to 10 euro /new /red  
'The price of the book is rising to 10 euros/#new/#red.'

Both *verfärben* and *steigen* can be combined with the scalar adverbs *graduell* 'gradually' and *sehr* 'very (much), a lot'. In (21), two attested examples of the modifiability of *verfärben* and *steigen* with *graduell* are listed. Without any coercion these verbs can be combined with *graduell* which modifies the progression of the change along a scale.

<sup>8</sup> Cf. Löbner (2012) for an overview of the various types of degree gradation found with verbs of different semantic classes.



- (21) a. [...] eine Beschichtung [...], die sich bei Einwirkung eines Desinfektionsmittels auch graduell verfärbt [...].<sup>9</sup>  
 '[...] a surface coating which gradually changes color if impacted by germicide [...].'  
 b. Juncker sagte dazu am Rande des Treffens, der Euro-Kurs habe sich nicht "brutal" nach oben bewegt, er sei graduell gestiegen.<sup>10</sup>  
 'Juncker said to this point in the margin of the meeting that the Euro exchange rate has not moved "brutally" upwards, it has only risen gradually.'

The examples in (22) show that the verbs *verfärben* and *steigen* can be graded like the scalar verb *verbreitern* 'widen'. The semantic effect of *sehr* is the same in all three cases: it specifies the extent of the change, i.e. the difference between the initial and final degree on the scale (cf. Fleischhauer, 2013).

- (22) a. Der Riss hatte sich sehr verbreitert.  
 the crack had REFL very widened  
 'The crack has widened a lot.'  
 b. Die Wäsche verfärbte sich sehr.  
 the clothes changed.color REFL very  
 'The clothes have changed their color a lot.'  
 c. Der Ölpreis ist sehr gestiegen.  
 the oil.price is very risen  
 'The price of oil has risen a lot.'

With regard to the deletion of the theme argument, *verfärben* and *steigen* exhibit some differences. As (23) demonstrates, the deletion of the theme argument of *verfärben* is not admissible.

- (23) a. Der Regen<sub>Causer</sub> verfärbt die Hausfassade<sub>Theme</sub>.  
 the rain changes.color the house.front  
 'The rain changes the color of the front of the house.'  
 b. \*Der Regen<sub>Causer</sub> verfärbt (sich).  
 The rain changes.color (REFL)  
 c. Die Hausfassade<sub>Theme</sub> verfärbt sich.  
 the house.front changes.color REFL  
 'The color of the front of the house changes.'

*Steigen* behaves differently with respect to the deletion of the theme argument. In (24) the subject is the complex NP *der Preis des Buches* 'the price of the book', in which the theme argument *Buch* 'book' is realized as "possessor" of price. As shown by the contrast between (24b) and (c), the theme argument can be deleted, but the noun introducing the scale cannot.

- (24) a. Der Preis des Buchs<sub>Theme</sub> ist gestiegen.  
 the price of.the book is risen  
 'The price of the book has risen.'  
 b. Der Preis ist gestiegen.  
 the price is risen  
 'The price has risen.'  
 c. #Das Buch ist gestiegen.  
 the book is risen

Our characterization of the possessor argument as the theme relevant to Rappaport's deletability criterion requires some clarification since it is not an argument of the verb, whereas the functional noun is the subject of *steigen* and thus can also be characterized as theme. We will elaborate on that issue in Section 5.

The application of the test criteria suggests that *verfärben* as well as *steigen* pattern with scalar CoS verbs rather than with lexically nonscalar incremental theme verbs and activity predicates like *shout*. In the next section we discuss the

<sup>9</sup> <http://www.patent-de.com/20010913/DE10065941A1.html> (15.7.2012).

<sup>10</sup> <http://m.faz.net/aktuell/wirtschaft/wirtschaftspolitik/wirtschaftspolitik-euro-laender-verpflichten-sich-zum-sparen-1435278.html> (15.7.2012).

typology of scalar (under)specification which results from distinguishing scalar verbs with regard to the scale parameters they lexicalize as part of their meaning.

#### 4. A typology of scalar (under)specification

In the preceding section we argued that *verfärben* and *steigen* are scalar verbs. This result is only compatible with the weak assumption that a CoS verb can be lexically scalar even though some or all scale parameters remain unspecified. We have also shown that *verfärben* and *steigen* differ with respect to the scale parameters they specify as part of their lexical meaning. The different types of scalar verbs are summarized in the typology of scalar (under)specification given in Table 2. The first type of scalar verbs lexically specifies all three scale parameters. This subclass consists of deadjectival verbs like *verbreitern* ‘widen’ but also of underived verbs such as *wachsen* ‘grow’. The second subclass of scalar verbs comprises verbs like *verfärben* and *verformen* ‘form into’ which lexically specify a dimension and the values whereas the linear order of the values remains unspecified. Finally, the third class is constituted by verbs like *steigen* ‘rise’, *fallen* ‘fall’ and *(ver-)ändern* ‘change’ which are completely underspecified with regard to the scale parameters when used intensionally. It is an open issue whether Table 2 shows all attested types of scalar underspecification or whether other patterns can be found. For example, are there verbs which lexically specify the dimension of the scale but not the values? The existence of such a type of scalar verb does not seem plausible given that the values are necessarily determined by a specific dimension. So the general question is whether all three scale parameters are logically independent of each other or not. However, in this paper we will not pursue this question further but rather focus on the three attested types of scalar verbs in Table 2.

Table 2  
Typology of scalar (under)specification.

Verb(s)	Unspecified in the verb meaning	Specified in the verb meaning
<i>verbreitern</i> ‘widen’, <i>wachsen</i> ‘grow’	–	All scale parameters
<i>verfärben</i> ‘change color’, <i>verformen</i> ‘form into’	Order of values	Dimension, values
<i>steigen</i> ‘rise’, <i>fallen</i> ‘fall’, <i>(ver-)ändern</i> ‘change’	All scale parameters	–

Another aspect comes into play if one takes a closer look at the verbs in the last row of Table 2. *Steigen* ‘rise’, *fallen* ‘fall’, and *(ver-)ändern* ‘change’ are all completely underspecified with regard to the scale parameters, but a comparison of the examples in (25) to (27) reveals that *steigen* and *fallen* specify the direction of change while *(ver-)ändern* does not.

- (25) *Die Temperatur steigt.*  
the temperature rises  
‘The temperature is rising.’  
→ The temperature is increasing.  
↔ The temperature is decreasing.

- (26) *Die Temperatur fällt.*  
the temperature falls  
‘The temperature is falling.’  
→ The temperature is decreasing.  
↔ The temperature is increasing.

- (27) *Die Temperatur ändert sich.*  
the temperature changes REFL  
‘The temperature is changing.’  
→ The temperature is increasing. or  
The temperature is decreasing.

If one assumes that the scale parameters in all of the three examples are already fixed by the noun *Temperatur* ‘temperature’, then the change expressed in all three cases is related to the same scale. *Steigen* and *fallen* express inverse directions of change: In (25) *steigen* indicates that the change leads to an increase of the temperature degrees whereas *fallen* in (26) refers to a decrease of the temperature degrees. By contrast, *(ver-)ändern* is compatible with an increase or a decrease of the temperature degrees, indicating that the direction of the change is not specified by the verb.

The examples show that in addition to the three scale parameters, a fourth parameter has to be assumed, namely the direction of the change, which is independent of the order of the scale values.

The direction of change is not a scale parameter; it rather specifies whether a change leads to an increase or decrease of values on the scale. *Wachsen* as well as *steigen* and *fallen* contain this component as part of their lexical meaning, but *verfärben* and *(ver-) ändern* do not. It is important to note that the CoS verb does not determine the order of degrees, i.e. the third scale parameter. Rather, it operates on the order of degrees/values introduced by the scale denoting noun. This becomes evident if one looks at the contrast illustrated in (28). Here, the CoS verb *zunehmen* ‘increase’, which is similar in meaning to *steigen*, is used intensionally and combines with the antonymous nouns *Helligkeit* ‘brightness’ and *Dunkelheit* ‘darkness’.

- (28) a. *Die Helligkeit nimmt zu.*  
the brightness increases PART  
‘The brightness is increasing.’  
b. *Die Dunkelheit nimmt zu.*  
the darkness increases PART  
‘The darkness is increasing.’

*Helligkeit* and *Dunkelheit* are both associated with the brightness-scale but exhibit an inverse ordering of degrees. If *Helligkeit* combines with *zunehmen*, this yields the interpretation that the brightness is increasing in the course of the event. By contrast, if *Dunkelheit* appears with *zunehmen*, the resulting interpretation is that the brightness is decreasing. This contrast would not be expected if the verb determines the order of values in addition to the direction of change. This makes verbs like *steigen* and *zunehmen* similar to the comparative, which also operates on the ordering of values that already comes with the adjectival base (cf. Kennedy, 1999; Kennedy and McNally, 2005). The similarity between (28) and adjectival comparison constructions is illustrated by the equivalent adjectival sentences in (29).

- (29) a. *Es wird heller.*  
it becomes brighter  
‘It is getting brighter.’  
b. *Es wird dunkler.*  
it becomes darker  
‘It is getting darker.’

In the preceding section we presented arguments in favor of the view that some or all scale parameters as well as the direction of change can remain underspecified in the meaning of a scalar verb. We then introduced a typology of scalar (under)specification in which three different types of CoS verbs are differentiated. For the sake of simplicity, we have not considered the different patterns of argument realization that can be found with CoS verbs. In the following section, we will give a short overview of the different argument realization patterns found with CoS verbs in German.

## 5. Argument realization of scalar verbs

Scalar verbs, i.e. CoS verbs, exhibit different argument realization patterns. Some of them, such as *wachsen* ‘grow’ in (30a), are used only intransitively, while others such as *verbreitern* ‘widen’ in (30b) have a basic transitive use.

- (30) a. *Der Baum wächst.*  
the tree grows  
‘The tree is growing.’  
a'. \**Die Sonne wächst den Baum.*  
the sun grows the tree  
b. *Das Erdbeben verbreitert den Riss.*  
the earthquake widens the crack  
‘The earthquake widens the crack.’

The single argument of an intransitive CoS verb like *wachsen* is a theme argument, i.e. the entity whose change is measured on a scale. By contrast, the subject of transitive CoS verbs like *verbreitern* refers to a causer while the theme argument is realized as the direct object. In German, reflexivization by means of the reflexive pronoun *sich* is a productive process to promote the theme argument to subject position and at the same time delete the causer argument as in (31).

- (31) *Der Riss verbreitert sich.*  
 the crack widens REFL  
 'The crack is widening.'

There is some debate about the result of this process. Is the reflexive form of *verbreitern* 'widen' in (31) transitive or intransitive? Does the reflexive marking lead to a decausativization, a deletion of the cause operator from the lexical semantics of the verb, or is the cause argument merely existentially bound, but the verb is still causative? We do not tackle these questions in this paper since they are not directly related to our claim that CoS verbs can be scalar without lexicalizing a complete scale. For further discussion see [Levin and Rappaport Hovav \(1995\)](#), among others.

As discussed in Section 3, one of the criteria for a verb to be lexically scalar is that the entity undergoing a change cannot be deleted. This is in line with the fact that CoS verbs always realize a theme argument. Verbs used intensionally, like *steigen* 'rise' in (32), deviate from this realization pattern. As (32b) shows, the argument undergoing the change can be freely dropped. By contrast, the intensional verb does not allow for the deletion of the functional noun as in (32c). This contrast to other types of CoS verbs is accompanied by a change in the syntactic status of the theme argument, which does not figure as a verb complement but is instead realized as a possessor argument of the noun. Since the realization of noun arguments is only optional, the omissibility of *Buch* comes as no surprise. On the other hand, *Preis* is a functional noun which takes a nominal argument. If this argument is not realized overtly, it is nevertheless understood that the price of something increases.

- (32) a. *Der Preis des Buchs<sub>Theme</sub> ist gestiegen.*  
 the price of.the book is risen  
 'The price of the book has risen.'  
 b. *Der Preis ist gestiegen.*  
 the price is risen  
 'The price has risen.'  
 c. *#Das Buch ist gestiegen.*  
 the book is risen

Taken literally, the change denoted by *steigen* is predicated of the referent of the subject *Preis*, which therefore can also be characterized as a theme. However, the theme relevant to Rappaport Hovav's deletability criterion is contributed by the possessor DP which refers to the participant whose property is measured on the scale. By contrast, the subject does not refer to a concrete participant but rather introduces the scale as such. Moreover, the possessor DP in intensional constructions of the type illustrated above systematically corresponds to the subject of CoS verbs which encode complete scales. For instance, (32a) can be paraphrased as in (33) with the verb (*sich*) *verteuern* 'become more expensive'.

- (33) *Das Buch hat sich verteuert.*  
 the book has REFL become.more.expensive  
 'The book has become more expensive'

In (33), the book figures as the theme undergoing the scalar change denoted by the verb. Since the meaning of *verteuern* comprises the meaning of the complex construction of functional noun and intensional verb, characterizing the semantic role of the possessor argument in a way different from that of the subject argument in (33) would miss an obvious parallel.

When used intensionally, verbs like *steigen* also undergo possessor-subject alternation (cf. [Levin, 1993:77f.](#)) as in (34b). Here, the possessor argument of the functional noun is promoted to subject position whereas the functional noun is realized within a PP headed by *in* 'in'.

- (34) a. *Der Preis des Buchs ist gestiegen.*  
 the price of.the book is risen  
 'The price of the book has risen.'  
 b. *Das Buch ist im Preis gestiegen.*  
 the book is in.the price risen  
 'The book has risen in price.'

Other types of CoS verbs do not permit the constructions in (34a) and (34b). They neither allow the theme argument to be realized as a possessor argument of a scale denoting functional noun as in (35a), nor do they undergo the possessor-subject alternation as in (35b).

- (35) a. \*Die Größe des Kindes wächst.<sup>11</sup>  
           the size of.the child grows  
       b. \*Das Kind wächst in der Größe.  
           the child grows in the size

Intensionally used verbs like *steigen* differ in their argument realization patterns from other scalar verbs, since they require the realization of a scale-denoting noun. The theme argument is either realized as a possessor argument of the subject NP or can be promoted to subject by the possessor-subject alternation. This shows that the deletability criterion is more subtle than assumed by Rappaport Hovav (2008). For certain verbs, or more exactly uses of verbs, it is possible to omit that argument, because it does not figure as a complement of the verb.

## 6. Resolution of scalar underspecification

Given the typology of scalar underspecification outlined above, we now come to the question of how the components which are missing in the meaning of verbs with incomplete scales can be specified in order to derive a complete scale. In general, we distinguish two strategies: scale composition and context/world knowledge, both of which will be addressed in the following. However, before discussing verbs with incomplete scales, we first have to look at verbs with complete scales such as (*sich*) *verbreitern* ‘widen’. Here, we build on the analysis by Kennedy and Levin (2008) who assume that a measure function constitutes the semantic core of verbs like *widen*. As illustrated for *verbreitern* in (36), the representation of the verb contains the measure function  $WIDTH(x,t)$  which maps individuals and times on degrees. *Verbreitern* can then be captured as an event at the end of which the width degree of some individual is more than its width degree at the beginning of the event.

- (36) *verbreitern* ‘widen’:  
 $\lambda x \lambda e. WIDTH_{\langle \Delta, D, R \rangle}(x, BEGIN(e)) < WIDTH_{\langle \Delta, D, R \rangle}(x, END(e))$

As indicated by the bracketed index, all three scale parameters are specified by the measure function, i.e., the value range of the function consists of ordered (R) degrees (D) of the dimension ( $\Delta$ )  $WIDTH$ . Note that our representation differs from the one proposed by Kennedy and Levin (2008) in that it makes explicit reference to the absolute degrees at the beginning and end of the event. By contrast, Kennedy and Levin make use of a difference function which returns relative degrees computed from the difference between the absolute degrees that hold at the beginning and the end of a change of state like *widen*. Kennedy and Levin’s representation of *widen* and the one in (36) are closely related and can be considered as variants which can be converted into each other. We retain the variant in (36) since our analysis of verbs like *verfärben* ‘change color’ in Section 6.2 requires explicit reference to the function values at the beginning and end of the event.

Since we do not aim to present an analysis of telicity, but only of scale composition, we do not deal with telicity in our representations. Nevertheless, we believe that our tentative account fits well with others that are intended to account for telicity such as the one of Kennedy and Levin (2008).

### 6.1. Scale composition

In scale composition, either the scale or some values along this scale are explicitly introduced by parts of the sentence other than the verb. With verbs like *steigen* ‘rise’ the scale is contributed by a functional noun which is realized as subject. Characteristically, verbs of this type have a literal use in which they lexicalize a complete scale. As illustrated in (37), *steigen* basically refers to a change of the vertical position of an object such that its height increases in the course of the event.

- (37) *Der Ballon ist gestiegen.*  
       the balloon is risen  
       ‘The balloon has risen.’

The meaning of *steigen* in (37) can be captured analogously to that of *verbreitern* in the preceding section. As stated in (38), *steigen* is defined as an event at the end of which the height of some individual is greater than its height at the beginning.

<sup>11</sup> A reviewer remarks that the English translations of the examples in (35) are fine. This is an interesting observation of a language-specific contrast which needs to be accounted for. We think that the English translations should be considered as instances of “overspecification” since both the verb and the noun encode the same dimension *SIZE*. Obviously, English allows for such a redundancy while it seems to be less acceptable in German. Formally, the English examples could be handled by means of unification.

- (38) *steigen* ‘rise’:  
 $\lambda x \lambda e. \text{HEIGHT}_{\langle \Delta, D, R \rangle}(x, \text{BEGIN}(e)) < \text{HEIGHT}_{\langle \Delta, D, R \rangle}(x, \text{END}(e))$ <sup>12</sup>

However, when a verb like *steigen* only explicates the direction of change, the scale is introduced by a scale denoting noun as in (39). Here, the nouns *Temperatur* ‘temperature’, *Preis* ‘price’, and *Druck* ‘pressure’ contribute a full-fledged scale.

- (39) a. *Die Temperatur der Flüssigkeit steigt.*  
 the temperature of.the liquid rises  
 ‘The temperature of the liquid is rising.’  
 b. *Der Preis des Apartments steigt.*  
 the price of.the apartment rises  
 ‘The price of the apartment is rising.’  
 c. *Der Druck in der Kabine steigt.*  
 the pressure in the cabin rises  
 ‘The pressure in the cabin is rising.’

The scale-denoting nouns in (39) can be analyzed as measure functions in the sense of Kennedy and McNally (2005). In this view, nouns of this type denote functions from individuals and times to degrees. Consequently, the nouns in (39) can be translated into the representations in (40).

- (40) a. *Temperatur* ‘temperature’:  $\lambda x \lambda t. \text{TEMPERATURE}_{\langle \text{Temp.}, \text{Temp. Deg.}, < \rangle}(x, t)$   
 b. *Preis* ‘price’:  $\lambda x \lambda t. \text{PRICE}_{\langle \text{Price}, \text{Price Deg.}, < \rangle}(x, t)$   
 c. *Druck* ‘pressure’:  $\lambda x \lambda t. \text{PRESSURE}_{\langle \text{Pressure}, \text{Press. Deg.}, < \rangle}(x, t)$

In (40a), the noun *Temperatur* ‘temperature’ is represented by the function  $\text{TEMPERATURE}(x, t)$ , which maps individuals and times onto temperature degrees. Similarly, *Preis* ‘price’ and *Druck* ‘pressure’ are represented as functions from individuals and times to price and pressure degrees, respectively. As indicated by the bracketed index, all three scale parameters are specified by the noun. For instance, the noun *Temperatur* ‘temperature’ comes with the dimension  $\text{TEMPERATURE}$ , temperature degrees, and an increasing order of temperature values. Likewise, the functions  $\text{PRICE}(x, t)$  and  $\text{PRESSURE}(x, t)$  map their arguments onto complete scales comprising a dimension, dimension-specific degrees and an increasing order of values.

If *steigen* ‘rise’ is combined with a scale-denoting noun like *Temperatur* ‘temperature’, we assume that the height scale, which is encoded by the verb in its literal use, is replaced by the scale contributed by the functional noun. Consequently, *steigen* in the abstract, metaphorical use can be conceived of as in (41). Here, it is represented as a predicate which selects a function from times to degrees and states that the value of the function at the beginning of the *steigen*-event is less than the value of the function at the end of the event. Moreover, it requires a function whose values are in a scalar order as indicated by the index in (41). This index excludes the combination of *steigen* with functional nouns such as *Farbe* ‘color’ which do not come with a scalarly ordered value range.

- (41) *steigen* ‘rise’:  $\lambda f_{\langle \Delta, D, R \rangle} \lambda e. f(\text{BEGIN}(e)) < f(\text{END}(e))$

The analysis of *steigen* in (41) yields the representation of *Die Temperatur der Flüssigkeit steigt* ‘The temperature of the liquid is rising’ in (42).

- (42) *die Temperatur der Flüssigkeit steigt* ‘the temperature of the liquid is rising’:  
 $\lambda e. \text{TEMPERATURE}_{\langle \Delta, D, R \rangle}(\iota x[\text{LIQUID}(x)], \text{BEGIN}(e)) < \text{TEMPERATURE}_{\langle \Delta, D, R \rangle}(\iota x[\text{LIQUID}(x)], \text{END}(e))$ <sup>13</sup>

Since  $\text{temperature}(x, t)$  has a scalarly ordered value range, it is a suitable functional argument of *steigen*. Note that the individual argument ‘x’ of  $\text{temperature}(x, t)$ , which is realized by the possessor DP *der Flüssigkeit* ‘of the liquid’, is saturated before the function is combined with the representation of *steigen* via functional application and the unification of scale parameters. If the possessor argument remains unrealized as in *Die Temperatur steigt* ‘The temperature is rising’, it can be comprehended as existentially bound. Since the saturation of the possessor argument takes place via nominal linking at

<sup>12</sup> The representation of the extensional reading of *steigen* is only tentative. In particular, it abstracts away from the path of the movement.

<sup>13</sup> For the sake of simplicity we leave the event argument unsaturated although the verbs in the examples are finite.



the DP-level, it is not passed on to the verb-level which would result in a transitive verb contrary to the facts. The saturation of the possessor necessarily precedes the combination of the functional noun and *steigen* in order to arrive at the semantic type of the functional argument 'f' required by *steigen*.<sup>14</sup>

Note that in sequences of functional noun and intensional verb like *die Temperatur steigt* 'the temperature is rising', the noun is characteristically accompanied by the definite article. Here, we follow Löbner's (1985, 2011) theory of definiteness, according to which the definite article has the function to indicate that the subsequent noun is to be construed as a functional (or individual) concept. The abstract functional nouns that co-occur with the intensional use of *steigen* and similar verbs are prototypical instances of this type of noun.

The representation in (41) retains much of the literal use of *steigen* in (38) and primarily abstracts away from the specific function which is encoded by the verb in its extensional use. In particular, the restriction to a function with a scalar value range and the direction of change, i.e. an increase of the values, is preserved in the meaning of *steigen* given in (41).

The combination of *fallen* 'fall' and *Temperatur* can be captured in a parallel fashion. As can be seen in (43), *fallen* differs from *steigen* only with respect to the direction of change: while *steigen* implies that the value of the function at the beginning of the event is smaller than the value at the end of the event, *fallen* involves the reverse relation with the function value at the end being smaller than at the beginning of the *fallen*-event.

$$(43) \text{ fallen 'fall': } \lambda f_{\langle \Delta, D, R \rangle} \lambda e. f(\text{BEGIN}(e)) > f(\text{END}(e))$$

Given the representation of *fallen* in (43), functional application and unification of scale parameters results in the representation of *Die Temperatur der Flüssigkeit fällt* 'The temperature of the liquid is falling' in (44).

$$(44) \text{ die Temperatur der Flüssigkeit fällt 'the temperature of the liquid is falling':} \\ \lambda e. \text{TEMPERATURE}_{\langle \Delta, D, R \rangle}(\lambda x[\text{LIQUID}(x)], \text{BEGIN}(e)) > \text{TEMPERATURE}_{\langle \Delta, D, R \rangle}(\lambda x[\text{LIQUID}(x)], \text{END}(e))$$

Other intensionally used verbs like *sich verändern* 'change' in (45) can be analyzed similarly to *steigen* 'rise'. *Sich verändern* also selects a function-denoting nominal as subject. However, in contrast to *steigen*, *sich verändern* does not express the direction of change but instead only states that the value of the function at the end of the event differs from the function value at the beginning.

$$(45) \text{ Die Temperatur der Flüssigkeit verändert sich.} \\ \text{the temperature of the liquid changes REFL} \\ \text{'The temperature of the liquid is changing.'}$$

The representation of *sich verändern* is given in (46). As can be seen, all that is stated is the inequality of the function values at the beginning and at the end of the event. The subscript 'C' indicates that the direction of change needs to be specified by the context since it is not part of the verb meaning.

$$(46) \text{ sich verändern 'change': } \lambda f \lambda e. f(\text{BEGIN}(e)) \neq_c f(\text{END}(e))$$

(47) shows the representation of the example in (45), which results from applying (46) to the function referred to by *Temperatur* after the possessor argument has been saturated.

$$(47) \text{ die Temperatur der Flüssigkeit verändert sich} \\ \text{'the temperature of the liquid is changing':} \\ \lambda e. \text{TEMPERATURE}_{\langle \Delta, D, R \rangle}(\lambda x[\text{LIQUID}(x)], \text{BEGIN}(e)) \neq_c \text{TEMPERATURE}_{\langle \Delta, D, R \rangle}(\lambda x[\text{LIQUID}(x)], \text{END}(e))$$

Unlike *steigen* and *fallen*, the direction of change remains unspecified in the case of *sich verändern*. However, it can be inferred from the context of the utterance and world knowledge (see next section) or it is made explicit by additional phrases which indicate the direction of change such as *um plus 3 Grad* 'by plus 3 degrees' and *um minus 5 Grad* 'by minus 5 degrees'. The resulting verbal complex of functional noun and intensional verb is scalar because *Temperatur* comes with a complete scale. However, as will be shown in the next section, *sich verändern* does not require the range of the function to be made up of scalarly ordered degrees and therefore can also combine with nonscalar functional nouns. By

<sup>14</sup> This however requires that functional composition is not accessible for the combination of *steigen* and functional noun. Given the compositional intricacies of intensional verb and functional noun we consider the formal analysis outlined above only as a tentative approach to the phenomenon.

consequence, the representation of *sich verändern* does not exhibit the subscripted scale parameters which exclude functional arguments with nonscalar value range in the representations of *steigen* and *fallen*.

## 6.2. Context and world knowledge

As illustrated in (48), *sich verändern* can also co-occur with nouns like *Farbe* ‘color’. We have argued in Section 2 that color space is structured but colors are not linearly ordered and thus do not constitute a scale. We therefore consider *Farbe* a nonscalar functional noun.

- (48) *Die Farbe des Blatts hat sich verändert.*  
 the color of.the leaf has REFL changed  
 ‘The color of the leaf has changed.’

(49) shows the representation of *Farbe* and the result of combining the noun with *sich verändern*.

- (49) a. *Farbe* ‘color’:  $\lambda x \lambda t. \text{COLOR}(x, t)$   
 b. *die Farbe des Blatts verändert sich* ‘the color of the leaf is changing’:  
 $\lambda e. \text{COLOR}(\iota x[\text{LEAF}(x)], \text{BEGIN}(e)) \neq_c \text{COLOR}(\iota x[\text{LEAF}(x)], \text{END}(e))$

In contrast to *die Temperatur verändert sich* ‘the temperature is changing’, the sequence of *Farbe* and *verändern* lacks both the direction of change and the order of values. However, the sentence in (48) can be uttered by someone who has observed the color change of the leaf and therefore knows at least about the initial and final state of this change. This background knowledge makes it possible to establish a minimal order of values. In addition to the situational context, our world knowledge of entities of different kinds can also provide a clue about the order of values along a specific dimension: the dimension referred to by a CoS verb is part of the attribute cluster of the referent undergoing the change (cf. Rappaport Hovav, 2008). For this referent, a specific value change of the attribute may be typical. For example, we know by experience that the foliage of trees changes in a characteristic way in fall. Therefore, we can assume a typical order of values for the situation referred to by the sentence in (48) if we interpret it as a description of the change of color of the fall foliage. Likewise, the sentence in (50) is interpreted as a color change from a normal complexion to a deep red usually accompanied by anger. By contrast, a change from red to pale would be uncharacteristic of the situation referred to in (50). Note that replacing *Wut* ‘anger’ with a different noun such as *Übelkeit* ‘nausea’ or *Kälte* ‘cold’ results in different colors associated with the change of complexion.<sup>15</sup>

- (50) *Sein Gesicht verfärbte sich vor Wut.*  
 his face changed.color REFL with anger  
 ‘His face changed color with anger.’

Alternatively, a minimal order of values and the direction of change can be established compositionally. For instance, by combining *die Farbe verändert sich* with PPs headed by *von* ‘from’ and *nach* ‘to’, one can specify the initial and final state of the color change as in (51).

- (51) *Die Farbe des Blatts hat sich von grün nach rot verändert.*  
 the color of.the leaf has REFL from green to red changed  
 ‘The color of the leaf has changed from green to red.’

(51) can be represented as in (52), in which the color values at the beginning and end of the event are specified by additional conjuncts:

- (52) *Die Farbe des Blatts hat sich von grün nach rot verändert.*  
 $\lambda e. \text{COLOR}(\iota x[\text{LEAF}(x)], \text{BEGIN}(e)) \neq_c \text{COLOR}(\iota x[\text{LEAF}(x)], \text{END}(e))$   
 $\& \text{COLOR}(\iota x[\text{LEAF}(x)], \text{BEGIN}(e)) = \text{green} \& \text{COLOR}(\iota x[\text{LEAF}(x)], \text{END}(e)) = \text{red}$

The representation in (52) can also be used as a starting point for a formal account of the examples in which the order of values is totally dependent on context and world knowledge. This account then would have to introduce some mechanism

<sup>15</sup> We owe this observation to an anonymous reviewer.

by which the additional conjuncts in (52) are contributed. However, the development of such a system clearly falls far beyond the scope of this paper.

The verb *verfärben* ‘change color’, which is nearly synonymous to *die Farbe verändert sich*, already encodes color as part of its lexical meaning and therefore does not depend on a functional noun. *Verfärben* does not encode a complete scale either since it also lacks the order of values. Consequently, the strategies applied to *verfärben* to arrive at a complete scale are the same as those for *die Farbe verändert sich*: If no linguistic material is added as in (53a), the order of values is construed from the situational context and/or from world knowledge. Alternatively, the direction of change can be specified by adding material like directional PPs referring to particular states of the color change as in (53b).

- (53) a. *Das Blatt hat sich verfärbt.*  
           the leaf has REFL changed.color  
           ‘The leaf has changed its color.’  
       b. *Das Blatt hat sich von grün nach rot verfärbt.*  
           the leaf has REFL from green to red changed.color  
           ‘The leaf has changed color from green to red.’

However, *verfärben* differs with respect to argument linking: While the theme argument is realized as the possessor of *Farbe* in *die Farbe verändert sich*, it shows up as subject of *verfärben*. As a result, it is realized by verbal linking in the case of *verfärben*, whereas it is already saturated at the DP-level in the complex construction. This difference is reflected in the representation of *verfärben* in (54) where the theme argument *x* appears as an unsaturated argument of the verb.

- (54) *verfärben* ‘change color’:  
 $\lambda x \lambda e. \text{COLOR}(x, \text{BEGIN}(e)) \neq_c \text{COLOR}(x, \text{END}(e))$

The above discussion shows that one can arrive at a complete scale with the help of contextual information and background knowledge. It is important to note that even without this additional information, the examples presented in this section are fully acceptable, i.e. the completion of missing scale parameters is not necessary for the grammaticality of sentences formed on the basis of verbs with incomplete scales. Instead we consider the strategies discussed in this section as a further means to achieve a full-fledged scale comparable to that of CoS verbs which encode complete scales.

## 7. Conclusion

The general goal of this paper was to explore RHL’s assumption that CoS verbs lexicalize scales. In accordance with that assumption, we discussed German examples like *steigen* ‘rise’, *(ver-)ändern* ‘change’ and *verfärben* ‘change color’ which behave like CoS verbs with respect to the relevant tests for scalarity. But at the same time they do not lexically specify all scale parameters. To account for this, we weakened the lexicalization assumption and proposed that CoS verbs can be scalar, even if they do not specify all scale parameters. In addition to using the German data to develop a typology of scalar (under)specification, they were also used to demonstrate how lexically underspecified verbs yield a full-fledged scale. Two factors turned out to be relevant: context/world knowledge and scale composition. As shown by the discussion of *verfärben* ‘change color’ and *die Farbe verändert sich* ‘the color changes’ in Section 6.2, it is the interaction of both factors that determines the scalarity and direction of change. In general, the analysis put forth in this paper emphasizes the contribution of the context and of scale denoting nouns to scalar change predications.

The account we presented can be extended to verbs denoting changes on two-point scales like German *umbenennen* ‘to rename’ and *den Wohnort wechseln* ‘to change residence’, which we have not discussed in the paper. The general idea of scale composition therefore equally applies to multi-point as well as two-point changes. Another way of extending our approach would be to look at directed motion verbs like *come*, *enter* and *reach* which seem similar to the CoS verbs discussed in our paper, since they also do not lexicalize all scale parameters (cf. Rappaport Hovav, 2008). Our analysis could be taken as suggesting that some incremental theme verbs may also be analyzed as lexicalizing an underspecified scale. However, the data discussed in Section 3 show that incremental theme verbs like *essen* ‘eat’ do not pass the scalarity tests in their intransitive use. Even if the scale is introduced by argument composition (cf. Kennedy, 2012), these verbs differ from change of state verbs such as *(ver-)ändern* ‘change’ in being not lexically scalar.

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